CHG LTR	ENGR APP	SECTION	DESCRIPTION	REL DATE

DRAWN BY:	DATE:
CHECKED BY:	DATE:
SYSTEM ASSURANCE MGR:	DATE:
LEAD DESIGN ENGINEER	DATE:
DESIGN ENGINEER	DATE:

REVISION: APPROVED BY (Section 514): DATE: 11/25/2009

APPROVED SOURCE(S)

VENDOR PART NO	VENDOR	GSFC PART NO
		2139300 2140300

THE ITEM LISTED IN THE APPROVED SOURCE BLOCK AND IDENTIFIED BY VENDOR NAME, ADDRESS AND PART NUMBER WILL BE EVALUATED AND TESTED BY THE GSFC ELECTRONIC PARTS ENGINEERING OFFICE OR ITS DELEGATED ALTERNATE BEFORE BEING APPROVED FOR USE. NON-GSFC USERS SHALL CHECK WITH THE ELECTRONIC PARTS ENGINEERING OFFICE ON THE STATUS OF THE PARTS APPROVAL BEFORE USING.

NASA Goddard Space Flight Center — CAGE NO 25306

Procurement specification: THIS DOCUMENT
Screening specification: THIS DOCUMENT
Custodian: Code 562.0, Parts, Packaging, and Assembly Technologies Office

TITLE:

Exhibit 1
SMAP LOW NOISE AMPLIFIER

DETAIL SPECIFICATION

2139300
2140300

1.0 SCOPE

This document establishes the requirements for the SMAP low noise amplifiers. These devices are intended for use in high reliability space flight hardware for the SMAP Radiometer and shall meet the specifications for a MIL-PRF-38534 Class K hybrid.

1.1 Part Identifying Number.

The complete procurement PIN for the LNA's supplied to this specification shall consist of a drawing number as follows.

Drawing Number	Description
2139300	**Amplifier, Engineering Model**
2140300	**Amplifier, Flight Model**

1.2 Absolute Maximum Ratings.

Absolute maximum ratings shall be as listed in Table I and shall be considered as survival limits. When returned to nominal operating conditions per Table II, full specification compliance is required.

Table I. **Absolute Maximum Ratings**

Parameter	Maximum Limits
Input Supply Voltage	+7.5 V DC
RF Input Power with internal power limiter	+27 dBm CW
Baseplate Temperature, Operating and Non-operating	–55 to +125°C –55 to +125°C

2.0 APPLICABLE DOCUMENTS

The following documents, of the issue in effect at the time of procurement, form a part of this document to the extent specified herein. In the event of conflict between this document and the referenced documents, this document shall take precedence.

Government

ASTM-B196/B196M	Rod and Bar, Copper-Beryllium Allow
ASTM-A484/A484M	Steel, Bars, Billets and Forgings, Stainless
MIL-DTL-28875	Amplifiers, Radio-Frequency and Microwave, Solid State, Specification for
MIL-STD-883	Test Methods and Procedures for Microcircuits
ASTM-D1710	Tubing, Extruded and Compression Molded Polytetrafluoroethylene (PTFE) Rod and Heavy Walled
SAE-AMS-I-23011	Iron-Nickel Alloys for Sealing to Glasses and Ceramics
SAE-AMS-2404	Plating, Electroless Nickel, Requirements for
MIL-PRF-38534	Hybrids, General Specification for
MIL-PRF-39012	Connectors, Coaxial, Radio Frequency, General Specification for
SAE-AMS-2422	Gold Plating, Electrodeposited
MIL-STD-1285	Marking of Electrical and Electronic Parts
S-311-M-70	Specification for the Performance of Destructive Physical Analysis
ESD S20.20	Electrostatic Discharge Control

American Society for Testing & Materials (ASTM)

ASTM B253	Standard Guide for Preparation of Aluminum Alloys for Electroplating
ASTM B308	Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles

NASA Goddard Space Flight Center (GSFC)

EEE-INST-002	Instructions for EEE Parts Selection, Screening, Qualification, and Derating Document

2.1 Order of precedence.

In the event of a conflict between the text of this drawing and the references cited herein, the text of this drawing takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3.0 REQUIREMENTS

Table II. 2139300 and 2140300 Amplifier Electrical Performance Characteristics from -10°C to +30°C

Parameter	Conditions 1/, 2/, 3/, 4/, 5/	Min. Limit	Max Limit	Units
Frequency Range	F_c = 1413.5 MHz	1400	1427	MHz
Noise Figure	Measurements shall be made in maximum increments of 1 MHz over 1400 to 1427 MHz band at baseplate temperatures (T_b) of -20 ºC, -10 ºC, 0 ºC, +10 ºC, +20 ºC, +23 ºC, +30 ºC, +40 ºC,		0.5	dB
Noise Figure versus Temperature	Computed from "Noise Figure" measurements above. (Condition 1/)		0.01	dB / ºC
Gain	Measurements shall be made in maximum increments of 100 kHz from band minimum to band maximum, and in maximum increments of 10MHz from 100 MHz to 10 GHz at (Tb) of -20 ºC, -10 ºC, 0 ºC, +10 ºC, +20 ºC, +23 ºC, +30 ºC, +40 ºC. All gain measurements shall be compliant with Figure 1.	29	31	dB
Gain Flatness	Over 1400 to 1427 MHZ band		0.1	dB
Gain Matching (Unit-to-unit)	Over 1400 to 1427 MHZ band	-0.5	0.5	dB
Gain Bandwidth Product			4000	MHz
Gain Variation versus Temperature	Computed from "Gain" measurements above. (Condition 1/)		0.015	dB / ºC
Phase Linearity	Over 1400 to 1427 MHZ band	-5	+5	Deg.
Phase Stability versus Temperature	Measurements shall be made at baseplate temperatures (Tb) of -20 ºC, -10 ºC, 0 ºC, +10 ºC, +20 ºC, +23 ºC, +30 ºC, +40 ºC, (Condition 1/)		0.07	Deg. / ºC
Phase Matching (Unit-to-Unit)	Over 1400 to 1427 MHZ band from one standard unit selected by vendor.	-5	+5	Deg.
Total Output Noise Power	Noise power output in the band DC to 26 GHz when the amplifier is terminated in a 50 Ω input load. This is to be measured with the amplifier (Tb) at -10 ºC, 23 ºC and 30 ºC.		-37	dBm
Output Power at 1 dB compression	Power Output at 1 dB compression measurements shall be made in maximum increments of 0.1 GHz from 0.5 to 2.0 GHz	+7.5		dBm
Input/Output VSWR			1.5 : 1	
Stability K Factor	Analysis using S-Parameters taken from 100MHz to 10GHz in 10MHz increments	>1		

	at temperatures -20 ºC, -10 ºC, 0 ºC, +10 ºC , +20 ºC, +23 ºC, +30 ºC, +40 ºC,			
Power Supply				
Supply Voltage		+4.9	+5.1	VDC
DC Supply Current			40	mA
RF Input Power Handling			+27	dBm CW

1/ Unless otherwise specified, measurements and calculations will be made at a frequency of 1413.5 MHz
2/ Unless otherwise specified, the term 'band' shall refer to the protected radio-astronomy frequency band of 1400 to 1427 MHz
3/ Unless otherwise specified, all tests performed on each device shall include connectors and limiters
4/ Unless otherwise specified, all measurements will occur using a 5.0V +/-0.1V regulated input power as specified in 3.3.1.
5/ Unless otherwise specified, all measurements will occur at a baseplate temperature (Tb) -10 ºC and +30ºC. and all requirements must be met within this range. The baseplate temperature is defined as the temperature of the baseplate mounting surface to which the LNA is attached. Any request for measurements outside this temperature range do not indicate a need for specification compliance at these temperatures but are for information purposes only.

3.1 General.

Manufacturing facilities used for the devices shall either be approved for listing on QML-38534 class K, or shall be approved by GSFC using criteria similar to MIL-PRF-38534 Appendix A.

3.1.1 Lot Travelers. Prior to the start of the fabrication, the manufacturer shall submit planned lot travelers to the procuring activity for review and approval. Travelers shall clearly identify all required test and inspection points, required electrical and environmental testing, test methods, test conditions, sample sizes, manufacturer and customer inspection points, etc.

3.1.2 Engineering Model Requirements. Engineering Model LNA's shall be the form, fit, and function equivalents of the Flight Model LNA's and shall be assembled and processed in the same manner. Engineering Model Parts shall be electrically tested in accordance with table II. GSFC will perform a pre-cap inspection of the Engineering Model Parts prior to lid seal. No additional screening or qualification testing is required for the Engineering Model lot.

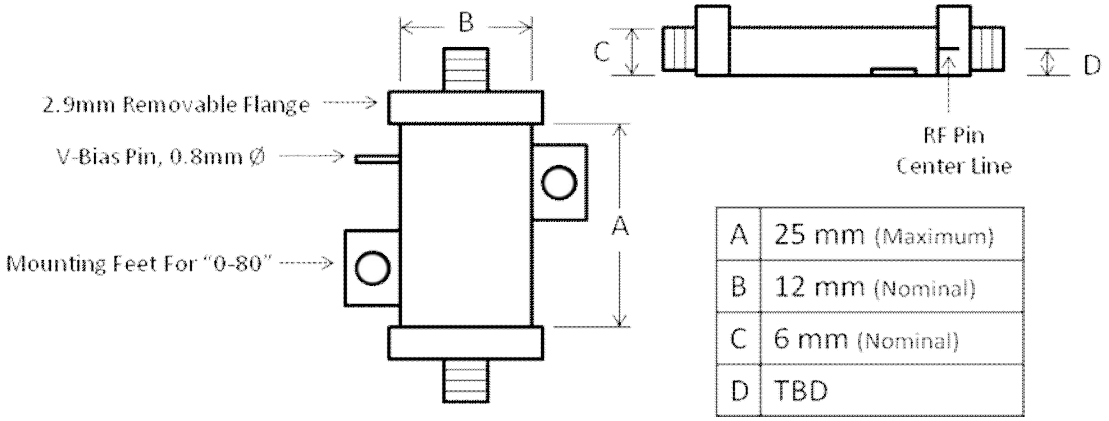
3.2 Design and Construction.

3.2.1 Amplifier Case Material and Finish. Amplifier case and lead material shall be Kovar (54% Iron, 29% Nickel, 17% Cobalt) in accordance with SAE-AMS-I-23011, class 1. Case and lead finish shall be gold in accordance with SAE-AMS-2422, type III, grade A, class 1, (50 microinches minimum) over electroless nickel plate in accordance with SAE-AMS-2404, class 1, grade A (100 to 200 microinches).

3.2.2 Case Outline. The amplifier case outline is shown in Figure 1 and includes the field replaceable connectors. Note: the amplifiers will be used by GSFC in both a coaxial and drop-in configuration. The amplifier package can employ a carrier if needed.

3.2.3 Connectors. The RF input and output connectors shall be a field replaceable 2.92mm (K) female flange mount connector with dimensions that shall be in accordance with 2-hole configuration MIL-PRF-39012/82 and shall mate with MIL-PRF-39012/79.

3.2.4 Construction. Devices shall meet the class K design, construction, rework, and hermeticity criteria of MIL-PRF-38534 Appendix E, Sections 3 and 4. Package dimensions shall be as indicated in Figure 1 – LNA Mechanical Dimensions.



A	25 mm (Maximum)
B	12 mm (Nominal)
C	6 mm (Nominal)
D	TBD

Figure 1 - LNA Mechanical Dimensions

3.2.5 Derating. Individual circuit elements shall be chosen such that they meet derating requirements of EEE-INST-002 when performing worst case element stress analysis per MIL-PRF-38534, Appendix E, Section 4.

3.2.6 Short Circuit Protection. Devices shall not be damaged if, after normal input voltage is applied to the device, the input supply is shorted to ground.

3.2.7 Negative Voltage Protection. The diode normally used to protect against negative voltage shall be removed and the negative voltage protection requirement is deleted.

3.2.8 Hydrogen Effects. Devices shall meet all performance requirements after exposure to hydrogen gas originating from within the hermetically sealed package.

3.2.9 Weight. The amplifier weight, including connectors, shall not exceed 25 grams.

3.2.10 Voltage Regulation. The device shall not employ an internal voltage regulator.

3.3 Electrical Performance.

Engineering Model and Flight Model Devices shall meet the performance requirements of Table II and herein. Devices shall also meet the general and the verification requirements specified in MIL-DTL-28875A and herein.

3.3.1 DC Supply Input Power. Devices shall meet electrical performance requirements with an input voltage of +5V +/- 0.1V and a maximum peak-to-peak noise (including ripple and spikes) of 50mV from DC to 200 kHz. Maximum input current shall be 40 mA over operational environmental ranges.

3.3.2 Input and Output Coupling. The input and output of each amplifier shall be AC coupled.

3.3.3 Stability. Devices shall remain unconditionally stable (no spurious oscillations). The amplifier shall meet the three (3) inequalities for unconditional stability in MIL-DTL-28875A and the output and input reflection coefficients shall be less than 1.00 for all frequencies from the lower to upper unity gain points for all magnitudes and phases of source and load impedances which do not have a negative real part. Data generated from 2-port s-parameters at -20, -10, 0 , +10, +23, +30 and +40 ºC shall be used to verify K-factors >1 and stability circles for source and load do not intersect the Γ=1 Smith chart circle at any frequency or phase angle from DC to 10GHz.

3.3.5 Gain. As specified in Table II, full 2-port S-parameters in the S2P format will be supplied at each temperature listed across the specified band. Gain shall be monotonic across the 1400 to 1427MHz band over the -10 ºC to +30 ºC temperature range.

3.3.6 Gain Flatness. As specified in Table II. Gain Flatness is defined as the maximum in band gain minus the minimum in band gain. The band is defined from 1400 to 1427 MHz. This is to be measured at the following temperatures: -20, -10, 0, +10, +20, +30, +40 ºC.

3.3.7 Out-of-Band Gain. The gain of the unit shall not exceed the gain specified in the following envelope:

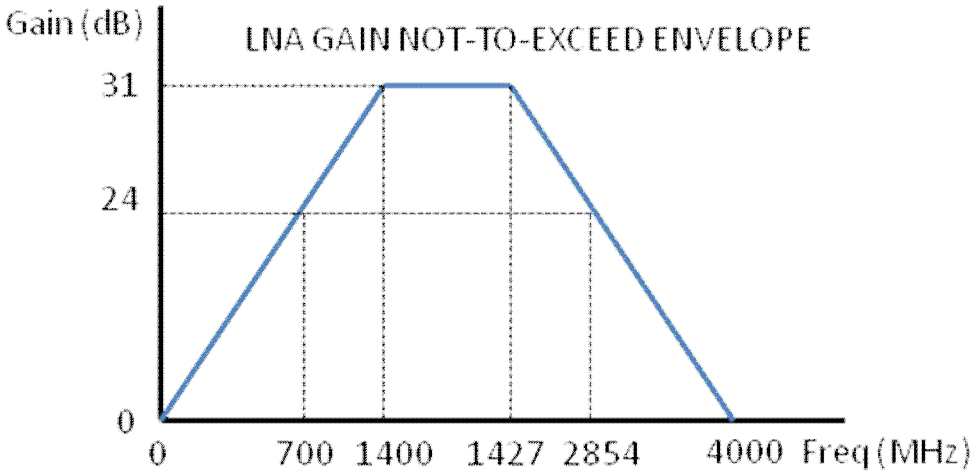


Figure 2 - LNA Gain Not-To-Exceed Envelope

3.3.8 Gain-Bandwidth-Product. As specified in Table II. The gain-bandwidth-product is defined as the frequency at which the gain of the unit is 0dB.

3.3.9 Gain Matching Unit to Unit. The vendor will select an amplifier unit to act as a reference. All other supplied amplifiers shall have gains within +/-1dB of this unit across the 1400 to 1427MHz band.

3.3.10 Maximum Noise Power Output. As specified in Table II when the amplifier is terminated in a 50 Ω input load. This is to be measured at the amplifier output using a broad-band power meter at amplifier temperatures of -10 ºC and +30ºC.

3.3.11 Phase Linearity. A linear line-of-best fit shall be fit to the plot of phase across the 1400 to 1427MHz band. All phase variations beyond this line shall not exceed the line by +/-5°.

3.3.12 Phase Matching Unit to Unit. The vendor will select an amplifier to act as a reference. All other supplied amplifiers shall match the phase of the reference within +/-5 ° across the 1400 to 1427MHz band.

3.4 Environmental Performance.

Devices shall meet all electrical performance requirements over all environmental requirements specified herein.

3.4.1 Temperature. Full electrical performance temperature range is -10 to +30 °C. Operating temperature range is -20 to +40 °C. Storage (Non-operating) temperature range is -55 to +125 °C.

3.4.2 Start-up. Amplifiers shall start operation, under any load condition and suffer no permanent degradation in performance after receiving bias voltage and RF input signal over the temperature range of -20 to +40°C.

3.4.3 Random Vibration. Devices shall be capable of meeting all performance requirements after exposure to random vibration, 3 minutes per axis x, y, and z, in accordance with Table III. For random vibration capability demonstration and qualification purposes, devices that marginally fail RF parameter performance limits may be used. Random vibration testing shall not be performed on deliverable flight amplifiers.

Table III. **Random Vibration Levels**

Frequency Hz	Flight Acceptance (FA) Acceleration Spectral Density	Qual/PF Acceleration Spectral Density
20 –50	+ 6 dB / octave	+ 6 dB / octave
50 –500	0.08 g^2 / Hz	0.16 g^2 / Hz
500 –2000	- 6 dB / octave	- 6 dB / octave
Overall	8.21 grms	11.61 grms

Qual: 2 minutes in each of the three axes. PF/FA: 1 minute in each axis.

3.4.4 Total Dose Radiation. Devices shall meet all electrical performance requirements after 20 kRad(Si) of total dose with dose rates of 0.005 Rad(Si)/sec and 50 Rad(Si)/sec.

3.4.5 Radiation Single Event Effects (SEE). Devices shall meet all electrical performance requirements after exposure with a linear energy transfer (LET) of up to 75 MeV/mg/cm^2.

3.4.6 Single Event Latch up (SEL) Devices supplied to this specification shall not latch up under any conditions.

3.4.7 Operating and Non-Operating Lifetime. Devices shall be capable of meeting all electrical and environmental performance requirements over the cumulative period of two years ground test, two years storage, and five years flight operation.

3.5 Marking.

Devices shall be marked as a minimum with GSFC part number, supplier code, date code, serial number, terminal identifiers (+5V, IN, OUT), and ESD sensitivity identifier. LNA's shall be marked in accordance with MIL-STD-1285, and as specified herein. LNA's that have successfully completed the quality assurance requirements of this specification shall be marked on the top surface (with respect to the normal mounting position) with the following minimum information. Ink shall be a contrasting, low outgassing, permanent ink, Hysol® Wornow M-Series ink, M-0-N (black), with Catalyst B-3, or equivalent.

3.6 Traceability.
Devices shall meet the class K traceability requirements of MIL-PRF-38534 Appendix F.

3.7 Problem Reporting.
The supplier shall notify GSFC within 24 hours of any element lot failures, any catastrophic failures after initial hybrid level electrical test, and any failures during screening or qualification testing.

3.8 ESD Safe Handling Precautions.
LNA's supplied to this specification are extremely ESD sensitive, and shall be handled in strict accordance with EIA-625 to prevent damage.

3.9 Workmanship.
LNA's supplied to this specification shall be uniform in quality and shall be free of seams, cracks, and other defects, which may affect life, serviceability, or appearance.

4.0 QUALITY ASSURANCE

4.1 Quality Assurance Program.
The Quality Assurance Program shall be in accordance with the vendor's current high-reliability policies and procedures in place at time of invitation for bid or proposal. Manufacturing processes, workmanship standards, procedures, inspection documents, facility and electrical test procedures shall be available for review and approval by the procuring activity's cognizant authorities.

4.2 Responsibility for Inspection.
Unless otherwise specified, the manufacturer shall be responsible for the performance of all tests and inspections specified herein. GSFC will perform pre-cap inspection of Engineering and Flight Model parts prior to lid seal.

4.3 Element Evaluation.
Element evaluation shall be performed in accordance with the class K requirements of MIL-PRF-38534 Appendix C.

4.4 Adhesives.
All polymeric adhesives used in the assembly of this device shall be certified to the requirements of MIL-STD-883, method 5011. Amplifier manufacturer is not required to perform the evaluations, but is required to obtain all certifications.

4.5 Process Control.

Wire bond process control testing shall be performed in accordance with the class K requirements of MIL-PRF-38534 Appendix C.

4.6 Screening.

Flight Model parts shall be screened in accordance with the class K screening requirements of MIL-PRF-38534 Appendix C, with the following additions and exceptions.

4.6.1 Burn-in. Burn-in conditions shall be +5VDC supply voltage and +125°C ambient temperature. RF input and output ports shall be terminated through 50 ohm loads to ground. Chart recorder shall be used to record supply voltage and ambient temperature. Baseplate temperature shall be recorded every 24 hours, except on Saturday and Sunday. Oven shall automatically shut down if ambient temperature is ≥ +135°C. DC power shall be regulated to prevent voltage spike during power on and power off.

4.6.2 Final Electrical. Final electrical test shall consist of Table II parameters as applicable. Electrical characteristics shall be measured as specified in the test plan approved by the procuring activity. All electrical data shall be recorded in the test reports. Final electrical test and Group A electrical test may be performed concurrently at manufacturers option.

4.6.3 Connector Savers. Connector savers shall be used on all RF connectors if they do not alter the RF performance characteristics following calibration; however, if connector savers cannot be used, then the number of mate-demates on each connector shall be minimized with no more than 10, and a mate/demate log shall be kept.

4.7 Qualification.

Flight Model Parts shall be qualified in accordance with MIL-PRF-38534 Appendix C and as specified herein.

4.7.1 Group B. Group B testing shall be performed in accordance with MIL-PRF-38534 Appendix C Paragraph C.6.3.2

4.7.2 Group C. Group C testing shall be performed in accordance with MIL-PRF-38534 Appendix C Table C-Xc class K condition QML. Subgroup 2 sample size shall be 5 pieces with zero failures.

4.7.3 Group D. The package element evaluation data, if from the same lot as used for deliverable flight units, shall satisfy the Group D requirement.

4.7.4 Destructive Physical Analysis (DPA). Devices shall be capable of meeting the DPA requirements of S-311-M-70. GSFC is responsible for performance of DPA.

4.8 Deliverable data package.

The deliverable data package to be supplied with each shipment of parts shall include the following items, as a minimum. Data shall be delivered, with the parts, to the procuring activity location specified on the purchase order or contract. Certificate of conformance, in accordance with MIL-PRF-38534. Copy of the lot travelers, from assembly through screening and TCI, as applicable. Attributes summary for all tests specified herein. Variables (read and record) data for pre- and post- burn-in electrical testing and pre- and post- life test electrical testing. Data shall be supplied in electronic form. Data retention requirements shall be a minimum of 5 years after delivery of product.

4.9 RF Data Package Deliverable.

In addition to data showing compliance with all aspects of Table II, RF performance data shall be supplied in .S2P (Full 2-port parameters) as applicable as stated in section 3.3.5.1

5.0 PACKAGING

Devices supplied to this specification shall be individually packaged to prevent mechanical damage and electrostatic discharge damage during shipping and handling. Connectors shall be capped with ESD-dissipative covers.

6.0 NOTES

6.1 Intended use.

Hybrids conforming to the requirements of this specification are intended for use for high reliability space flight applications, Government hybrid applications, design applications, and logistics purposes.

6.2 ESD Safe Handling Precautions.

Hybrids supplied to this specification are extremely ESD sensitive, and shall be handled in strict accordance with ESD S20.20 to prevent damage.